



Summary of the August 14 – 15, 2002, Experts Workshop on Public Health Impacts of Sewer Overflows

Summary of the August 14 – 15, 2002, Experts Workshop on Public Health Impacts of Sewer Overflows

Table of Contents

Abstract.....	1
Background.....	1
Rationale for the Workshop.....	1
Opening Remarks.....	3
Review of Goals and Agenda.....	3
Overview of the 2001 and 2003 Reports to Congress.....	5
The Public Health Chapter of the 2003 CSO/SSO Report to Congress:	
Questions and Proposed Methods.....	8
Discussion Session 1: Characterizing Pathogens and Pollutants.....	13
Discussion Session 2: Pathways of Exposure.....	22
Discussion Session 3: Open Discussion Session.....	25
Welcome and Structure of Day Two.....	26
Breakout Session A: Significance of the CSO and SSO Problem.....	26
Breakout Session B: Options for the Current Study.....	28
General Discussion.....	30
Final Comments and Next Steps.....	31

Appendices

Appendix A: Attendee List

Appendix B: Agenda

Appendix C: Clarifying Questions from Observers

Appendix D: The Public Involvement Process for the 2001 and 2003 Reports to Congress

Abstract

In embarking upon the task of assessing the human health impact portion of Congress' request for a report on the impacts and control of sewer overflows in the United States, initial research revealed that relatively little data were available that linked waterborne illness or other exposures to combined sewer overflows (CSOs) and sanitary sewer overflows (SSOs). In response to these challenges, EPA held a Public Health Impacts Experts Workshop on August 14 and 15, 2002. A group of nine external and EPA experts in public health, epidemiology, and wastewater treatment attended the workshop. Observers included representatives of stakeholder groups and EPA personnel. This workshop did not constitute an advisory committee under the Federal Advisory Committees Act (FACA), but rather solicited individual opinions and provided a forum for information exchange related to this Report to Congress.

Background

In the Consolidated Appropriations Act for fiscal year 2001, also known as the “Wet Weather Water Quality Act of 2000” or “2000 Amendments to the Clean Water Act” (CWA), Congress made several changes to the CWA regarding combined sewer overflows (CSOs) (P.L. 106-554). Among these changes was a requirement for the U.S. Environmental Protection Agency (EPA) to provide two Reports to Congress. The first report, *Implementation and Enforcement of the Combined Sewer Overflow Control Policy* (EPA 833-R-01-003), was delivered on January 29, 2002. The second report, which is due to Congress on December 15, 2003, is to investigate:

- The extent of the human health and environmental impacts caused by municipal CSOs and sanitary sewer overflows (SSOs), including the location of discharges causing such impacts, the volume of pollutants discharged, and the constituents discharged;
- The resources spent by municipalities to address these impacts; and
- An evaluation of the technologies used by municipalities to address these impacts.

Rationale for the Public Health Experts Workshop

In embarking upon the task of assessing the human health impact portion of Congress' request, initial research revealed that relatively little data were available that linked waterborne illness or other exposures to CSOs and SSOs. Factors complicating collection of information and data in this arena include public perception of reporting overflows in recreational areas; difficulty in contributing CSO/SSO loadings of pathogens in our nation's waters from other background sources; multiple possible pathways for fecal-related illness; underreporting of certain types of waterborne illnesses; and a lack of comprehensive local or national tracking for such illnesses.

In response to these challenges, EPA held a Public Health Impacts Experts Workshop on August 14 and 15, 2002. The purpose of this workshop was to enlist technical and subject matter experts from federal agencies, local health departments, and academia to ensure that EPA frames the study questions correctly, benefits from all pertinent data, and develops a methodology that bears out actual experiences. A group of recognized experts in the field of public health and interested observers met with the goals and objectives of:

- Fully elucidating the issues and the magnitude of those issues associated with health impacts of CSOs and SSOs;
- Reviewing and supplementing data and information sources identified to date; and
- Critiquing the proposed methodology for gathering and analyzing the public health information and data for the 2003 report.

The experts were asked to give individual opinions relating to the study questions. No consensus opinions or policy recommendations were solicited.

This Public Health Experts workshop is part of a larger public involvement process for the 2001 and 2003 CSO/SSO Reports to Congress. It occurs between two broader stakeholders' meetings (June 2001 and summer 2003, anticipated), at which a broad range of stakeholders discuss and provide input on draft report findings and recommendations, experiences in CSO control, and future policy and program directions. For a more detailed discussion of the overall stakeholder approach, please refer to Appendix D of this summary.

Workshop Summary

Wednesday August 14, 2002

Opening Remarks by Jim Hanlon, Director, EPA Office of Wastewater Management

Mr. Hanlon welcomed the participants and observers to the workshop. He stressed that convening this workshop did not constitute an advisory committee under FACA. While a FACA committee's purpose is to provide consensus, this meeting solicited individual opinions and provided a forum for information exchange. The participants were not asked to recommend directions for EPA's policy or programmatic agendas. Mr. Hanlon reviewed the scope of the 2003 Report to Congress. He expressed his hope that some information gathered for the 2003 report also will be incorporated into the preamble of EPA's draft proposal on SSOs, which the Agency hopes to propose in 2003. He added that the body of the rule is not likely to change much from the previously published version and that comments and additional information will be reflected in the preamble.

Mr. Hanlon noted that relatively little is known about the current incidence and impacts of SSOs in the United States. He stated that, in addition to the ongoing efforts under the 2003 Report to Congress, EPA is developing an Information Collection Request (ICR) [no. 2063.01, approved by the Office of Management and Budget (OMB) on September 16, 2002] that will enable the Agency to collect better data for the report and thereby expand the arena of SSO knowledge. This workshop and the data gathered for the 2003 Report to Congress will complement the SSO rule making effort.

Finally, Mr. Hanlon noted that EPA would continue to request the input and cooperation of the public health community. One of the most positive outcomes hoped for as a result of this workshop is a strengthening of connections between individuals in the academic and technical communities that the Agency can draw upon in the future.

Review of Goals and Agenda by Linda Manning, Marasco Newton Group Facilitator

Ms. Manning welcomed the participants and reviewed with the group the purpose of the meeting and the agenda for the two days. She solicited input as to whether anything significant had been left off the agenda. She explained that the meeting was structured to get the experts to place themselves in EPA's position in having to answer the public health impacts question and get them to think through factors and nuances of such a study. She then explained to participants how this effort related to other public involvement processes for both the 2001 and 2003 Reports to Congress. She mentioned that EPA held an open stakeholder meeting in July 2001 to discuss the preliminary findings of the 2001 report. A summary of this meeting was included, as Appendix I, in the 2001 report. A similar meeting is planned in advance of the release of the 2003 report. The major difference between this workshop and the large stakeholder meetings is that the goal of the

present meeting is strictly to discuss the methodological and information issues surrounding the public health component of the 2003 report. The stakeholder meetings provide a forum for broader policy discussion.

Identifying and Inviting the Experts

Ms. Manning explained the selection of participants for this workshop. First, Marasco Newton Group solicited names of possible experts in public health, epidemiology, and wastewater treatment from EPA staff, key authors of relevant literature, and an ad hoc consultation group made up of representatives from the Association of Metropolitan Sewerage Agencies (AMSA), the CSO Partnership, the Natural Resources Defense Council (NRDC), and the Water Environment Federation (WEF). Marasco Newton Group facilitators called this initial group of 36 people, which included EPA experts, and had conversations with them based on the following questions:

- Please describe your experience in the areas of public health impacts associated with the major study questions.
- Are there specific data sources that you would recommend using to answer the major study questions?
- Do you have any interest in attending this workshop?
- Can you recommend others that would be particularly good contacts or potential experts?

The facilitators then called all the people recommended by the initial contacts. After nearly 100 interviews, the final list of experts were invited based on relevance of their work to the specific connections between sewage and illness, disciplines they represented, geographic distribution, and representation in types of agencies (e.g., local government, EPA, federal government, academia). Of the final group of nine experts that attended the workshop, three were from EPA and six were external to the Agency. The EPA experts came from the Office of Research and Development's National Exposure Research Laboratory (NERL), the National Health and Environmental Effects Research Laboratory (NHEERL), and the National Risk Management Research Laboratory (NRMRL).

Developing the Agenda and the Role of the Observers

The ad hoc consultation group from AMSA, CSO Partnership, NRDC and WEF was asked to review an initial agenda for the meeting and provided comment on the framing of the questions and parameters of the study. Comments were solicited and discussed via conference call. The facilitators wanted to limit the technical and scientific discussion to public health experts, but felt it was critical to ensure that the discussion took place inside of a broader policy discussion. The ad hoc group was designed to provide that perspective. Observers from the ad hoc group also attended the meeting (see Appendix A for a complete list of attendees) and had opportunities to

ask clarifying questions of the experts during the workshop. For a list of questions, see Appendix B.

Ms. Manning concluded with some thoughts on the nature of this workshop:

- All research and methodologies should be considered working drafts.
- Preliminary research indicates that actual public health impacts resulting from sewer overflows are largely unknown and available data are neither comprehensive nor consistent.
- Impact assessments for this Report to Congress are to be made based on existing information.
- One possible outcome may be that the study highlights not only what is currently known about the health impacts of sewer overflows, but also the areas where data are lacking.

Overview of the 2001 and 2003 Reports to Congress, Kevin DeBell, EPA Office of Wastewater Management

Mr. DeBell provided an overview of the legislative, regulatory, and programmatic background to the CSO/SSO issue and an overview of the major findings of the 2001 Report to Congress. Mr. DeBell also presented a brief overview of the proposed methodology and key research questions for the 2003 Report to Congress, describing the context for the public health component.

An Introduction to Combined Sewer Overflows

Mr. DeBell explained that combined sewer systems (CSSs) are wastewater collection systems designed to carry sanitary sewage, industrial and commercial wastewater, and storm water runoff in a single system of pipes to a publicly owned treatment works (POTW). During dry weather, all flow (composed primarily of sanitary sewage and industrial/commercial wastewater) is conveyed to the POTW.

During periods of rainfall or snow melt, the total wastewater flows entering the collection system can exceed the capacity of the system or the treatment facility. Under such conditions, CSSs are designed to discharge excess wastewater flows directly to surface water bodies such as lakes, rivers, estuaries, and coastal waters.

CSOs are point source discharges subject to National Pollutant Discharge Elimination System (NPDES) permit requirements, including the technology-based (Nine Minimum Controls) and water quality-based requirements of the CWA. CSOs are not subject to the secondary treatment requirements applicable to POTWs.

As of June 2001:

- 772 communities in 32 states have CSSs;
- Communities with CSSs are concentrated in the Northeast and Great Lakes regions;
- These CSOs are regulated by 859 NPDES permits;
- The permits authorize discharges from 9,471 outfalls as many permitted CSSs have multiple discharge points; and
- Different communities employ different levels and types of control.

An Introduction to Sanitary Sewer Overflows

Mr. DeBell differentiated CSSs from separate sanitary sewer systems. Properly designed, operated, and maintained separate sanitary sewer systems collect and transport wastewater only to a POTW. Storm water is conveyed in a separate system from sanitary wastes. These systems are not designed to overflow during wet weather discharges, but are not immune from problems. Occasional unintentional discharges of raw sewage from municipal sanitary sewers, or SSOs, occur in almost every system due to a variety of causes such as illegal connections, blockages, deterioration of the sewer infrastructure, or poor operations and maintenance. SSOs are difficult to predict and manage because they can occur at any point in the collection or treatment system.

EPA is currently working to examine the state of SSOs in the United States. Some preliminary data gathered for this report are listed below:

- In 2000, EPA estimated 40,000 SSOs and 400,000 basement backups annually (Note: EPA will revise these estimates based on data collected for the 2003 Report to Congress);
- The majority of SSO events are smaller in volume than CSO events; and
- States have different methods and thresholds for reporting and tracking SSOs.

The Problem of CSOs and SSOs

The CSO/SSO problem is complex, involving site-specific variability in types of systems, volume, frequency, and other characteristics. Because CSOs and SSOs are discharges of raw sewage, they contain a combination of untreated human waste and pollutants discharged by commercial and industrial establishments. CSOs and some SSOs also have a significant storm water component that includes pollutants from urban and rural runoff. These pathogens, solids, and toxic pollutants may be discharged directly to receiving waters such as lakes and rivers.

As described in the 2001 Report to Congress, *Implementation and Enforcement of the Combined Sewer Overflow Control Policy*, substantial documentation of the consequences of CSOs became available in the early 1990s. In reports by the Natural Resources Defense Council, the Center for Marine Conservation, the National Oceanic and Atmospheric Administration (NOAA), and EPA,

hazardous debris such as medical, drug, and sewage-related debris were found on beaches, in ocean waters, and in lakes and rivers, all resulting from CSOs. CSO-related wastes such as condoms, tampon applicators, fecal matter, grease, and food were found in New York waters.

According to a January 11, 2001, EPA fact sheet, *Why Control Sanitary Sewer Overflows?* (<http://www.epa.gov/npdes/sso/control/index.htm>), sewer overflows are a human health issue because they can create the potential for exposure to disease-causing pathogens, including protozoa, bacteria, and viruses. Activities involving exposure to CSO contaminants through swimming or other contact can lead to infectious diseases such as hepatitis, gastrointestinal disorders, dysentery, and swimmer's ear. Other forms of bacteria can cause typhoid, cholera, and dysentery. Human health also can be impacted from ingesting fish or shellfish contaminated by CSO discharges.

In response to these challenges, the Wet Weather Water Quality Act of 2000 called for a Report to Congress to assess the progress made by EPA, states, and municipalities in implementing and enforcing the 1994 CSO Control Policy. This report was delivered to Congress in January 2002. The major findings of this report were:

- Data collection from CSO control activities and water quality monitoring have not been performed in a uniform manner.
- The 1994 CSO Control Policy raised awareness and catalyzed actions to control CSOs in many communities.
- A few proactive states took the initiative in many of these cases.
- EPA estimates that since 1994, CSO controls have resulted in a 12 percent reduction in untreated CSO volume and pollutant loadings, a 170 billion gallon annual decrease in CSO volume, and an annual decrease of biochemical oxygen demand loadings by 125 million pounds per year.
- The financial resources to address CSOs are substantial. EPA's 1996 National Needs survey estimated a cost of \$44.7 billion need to control CSOs.

The 2000 amendments also call for EPA to produce a second Report to Congress, due in December 2003. As stated above, the 2003 report shall summarize:

- The extent of the human health and environmental impacts caused by municipal CSOs and SSOs, including the location of discharges causing such impacts, the volume of pollutants discharged, and the constituents discharged;
- The resources spent by municipalities to address these impacts; and
- An evaluation of the technologies used by municipalities to address these impacts.

The data collection effort for the 2003 report began with a series of literature reviews. Presently, the report team has visited several states and will go to several more over the course of the study. At the state level, the report team is collecting information from the NPDES authority, state water quality agency, and some communities. The focus for the human health section of the report will

rely largely on community-level data sources. The anticipated time line for the remaining tasks is:

- Fall 2002 – Continue data collection.
- Spring 2003 – Complete first draft of report.
- Spring/summer 2003 – Hold inclusive stakeholder meeting.
- Fall 2003 – Deliver report to OMB.
- December 2003 – Deliver to Congress.

The Public Health Chapter of the 2003 CSO/SSO Report to Congress: Questions and Proposed Methods by Greg Frey, Marasco Newton Group

Mr. Frey reviewed the research questions and methodology in order to get feedback on sources, data, and study approach from the individual experts. Mr. Frey reviewed for the group some of the larger questions comprising this study:

- What is the nature of health problems associated with raw sewage discharges from CSOs and SSOs? How serious are they?
- What are the most acute and the long-term impacts from sewage exposure?
- Which exposure routes are the most significant, and what populations are most threatened?
- What are impediments to better understanding of the linkages between human health threats, exposures, and human health impacts?
- How do the human health threats associated with exposure to raw sewage compare with other health problems?

Mr. Frey also pointed out that by conducting this study, EPA can gain some additional benefits such as:

- Improving the information platform for SSOs/CSOs;
- Improving measurement and reporting of environmental and public health impacts from the municipal side of the NPDES program; and
- Strengthening public health considerations in EPA program planning and implementation.

He went on to articulate a number of challenges associated with calculating health impacts from CSOs and SSOs. These include:

- A complex study universe, given that overflows occur at many different points in a conveyance or treatment system;
- Variability in thresholds for reporting SSOs (e.g., How many gallons constitutes an overflow?);

- Health impacts are difficult to attribute to a specific pathogen source (e.g., food, water, or personal hygiene); and
- Health impacts are not consistently investigated, managed, or reported.

To achieve the best possible description, the study approach follows the environmental fate of pollutants and pathogens found in sewage effluents, from their introduction into the environment, to the exposure of certain populations, to the incidence of adverse health effects. This chapter of the report will consist of sections that characterize the potential human health threats, pathways of exposure, the incidence of human health impacts, and actions taken to protect human health.

Report Section 1: Characterizing Potential Human Health Threats from Sewer Overflows

The report team will review and summarize articles on sewage effluents, their sources, and pollutants in order to characterize the potential for hazards to human health. In this section of the report, we plan to investigate distinctions between the pollutants from sewage overflows and other non-point sources (e.g., urban runoff or animal feeding operations). The report team will not distinguish between CSO and SSO effluents in this section of the study unless dilution of flow is found to be significant to this section. We also may discuss emerging issues, such as non-traditional pollutants (e.g., pharmaceuticals and personal care products) that require future research efforts. The report team will utilize reports and data from federal agencies, such as EPA, the U.S. Geological Survey (USGS), and the Centers for Disease Control and Prevention (CDC), and non-governmental organizations (NGOs), such as the Surfrider Foundation and NRDC.

Key questions for this section include:

- What pathogens and pollutants are present in sewage overflows?
- What are the associated human health threats?
- What are the sources of pathogens similar to those in raw sewage?
- What are the indicators of human health threats from polluted waters?

Report Section 2: Characterizing Potential Exposures

The report team will use available answers to the questions listed above, along with reports from EPA, state, and local agencies, to describe the exposure pathways and at-risk populations in the second section of the study. The most common exposure pathways are:

- Direct recreational contact;
- Water-related, food-borne illnesses (ingestion of contaminated fish or shellfish);
- Ingestion of contaminated drinking water;
- Direct contact or inhalation from basement backups or flooding; and
- Occupational direct contact or inhalation.

We also plan to investigate the populations that face the highest threats for adverse health impacts associated with sewage overflows. We will rely on epidemiological data gathered from the literature review and interviews with state and local health personnel to describe those illnesses that impact specific populations more than others. Demographic information gathered from NPDES authorities and state or local public health personnel also will provide insight into potential environmental justice issues for the most affected people. Community case studies, selected to demonstrate the complexity of the CSO and SSO universe, will complement this discussion by providing specific examples of exposures.

Key questions for this section include:

- What are the potential exposure pathways for waterborne illnesses?
- Which populations face the greatest exposures?
- Which populations are most sensitive?
- What temporal and climatic characteristics are associated with different levels of contaminants causing waterborne diseases?

Report Section 3: Characterizing Human Health Impacts

The report team will use reports from the CDC, state epidemiologists, community public health personnel, and the literature review to summarize the reported incidence of illness and disease in the United States, specifically the number resulting from sewage overflows. We will use data from the literature review to distinguish between short-term illnesses and chronic conditions resulting from, or exacerbated by, sewage overflows. Because of the inconsistencies in monitoring, reporting, and data tracking, the report team plans to supplement the section on incidence of disease with data gathered in the state and community interviews.

Key research questions for this section include:

- What is the extent of waterborne disease in the United States?
- What reporting and tracking mechanisms exist (at the federal, state, and local level) for waterborne disease?
- How many and what types of adverse health effects are attributed to sewage?
- What indicators or thresholds are used to define waterborne disease outbreaks (WBDOs)?
- How are human health threats communicated, prevented, and mitigated?

Major Research Steps

We plan seven general steps for the public health impacts section of this Report to Congress. These are:

1. Literature and organizational review;

2. Experts workshop;
3. State and community interviews;
4. Compilation and summarization of data;
5. Community case studies;
6. Confirming interviews; and
7. Analysis to answer study questions.

Step 1: Literature review

The purpose of the literature review is to evaluate the state of knowledge linking sewer overflows (from both combined and sanitary sewer systems) to public health impacts across the United States. To counter the paucity of data, the report team looked specifically for papers or reports that would speak to one link in the suspected causal chain for potential overflow-related illness.

Databases used to find relevant epidemiological and environmental data were PubMed, Toxline, and LexisNexis. Once specific articles were identified, they were retrieved from on-line sources. Those articles not available on-line were retrieved from the National Library of Medicine in Bethesda, Maryland. The report team also researched and reviewed relevant agency and interest group reports for articles and data related to the study area. Information was gathered on the general incidence and characteristics of waterborne illness or diseases, as well as other impacts associated with contaminants found in CSO or SSO effluents. Mr. Frey noted that this was, and continues to be, an iterative process, refining the search as more data become available through review and discussions with experts. Any reports of linkages between CSOs and SSOs and acute human health impacts are highlighted for potential use in the case study component of the report. To date, very little information linking waterborne diseases to CSOs or SSOs was uncovered.

Step 2: Experts workshop

The experts workshop, described above, is the second step in the development of the public health impacts section of this report.

Step 3: State and community interviews

The report team will conduct interviews with public health personnel. State or territorial epidemiologists and local public health officials will likely be the primary sources of information. Throughout the literature review, the report team identified candidate communities with a history of health impacts from sewage overflows and will begin the data collection process there, as these communities may be furthest along in connecting wastewater management with health impacts. EPA will ensure geographic, climatic, and population variability among communities interviewed. Communities also will be selected to provide a discussion of the range of programs in place for monitoring and evaluating the impacts of CSOs and SSOs, from the most advanced to the nonexistent. The report team will draw from communities that experience the largest loadings from CSOs and SSOs, those that have large groups of sensitive populations, and those with a

tradition of attention to public health and environmental issues. During these interviews, the report team will gather information on the incidence of sewage overflows, as well as specific data on exposure rates, patterns, and illness tracking for the second and third sections of the public health chapter of the Report to Congress.

Step 4: Compilation and summarization of data

The report team will analyze the collected literature to evaluate the quality and adequacy of the data for the purpose of answering the study questions. Outstanding data gaps also will be identified at this point. To the extent possible, EPA will compile data on the constituents of sewage effluents; documented exposure pathways; proven temporal, seasonal, or climatic trends in WBDs; studies of sensitive populations (either through greater exposure or higher susceptibility to adverse health impacts); the types of illnesses and diseases that occur from WBDs; documented reporting and tracking mechanisms; risk communication practices; and associations with CSOs and SSOs.

Step 5: Community case studies

On the basis of the data collected in the literature review, the experts workshop, and the state and community interviews, EPA will attempt to identify WBDs or human health impacts linked to CSOs and SSOs for use as case studies in the human health section of this report. The report team will stratify this universe of localities by variables such as population served, type of sewershed, geography, associated water quality impairments, and annual precipitation (both quantity and quality). The case studies also will try to reflect and further elucidate the spectrum of exposure pathways: drinking water contamination, food (fish/shellfish), recreational waters, occupational exposures, or basement/flood-related exposures.

Step 6: Confirming interviews

The report team will conduct additional or follow-up interviews with selected public health officials in the interest of eliminating data gaps and validating assumptions that exist at this point in the report development process. Case studies will be presented and discussed with community representatives to ensure that they accurately characterize the conditions and incidents described. This round of interviews will serve as a preliminary quality assurance process for data collected.

Step 7: Analysis to answer study questions

Once the follow-up interviews are complete, the report team will conduct a final analysis of the study data. We will compile the sources identified in previous steps, analyze trends in the data, and discuss key questions and issues. This section will include a comprehensive understanding of waterborne disease, a list of the pathogens and pollutants expected to be associated with CSOs and SSOs, a discussion of all potential pathways for exposure, a description of at-risk groups, and a relative sense of research on the associations between SSOs and CSOs and human health.

Using data from these events, estimates of underreporting gathered in the literature review, and data gathered for other chapters of this report on the prevalence of CSO and SSO events, one option is to scale up the findings to estimate both the high- and low-end potential for national human health concerns. This process will depend on the reliability of the available data. This type of analysis would require the assumption that these numbers represent only the possible range of impacts. At a minimum, EPA will identify the data elements needed at the federal, state, and local levels to support future EPA efforts to determine the real magnitude of human health impacts from CSOs and SSOs. This workshop, the literature review, and interviews with states and communities will support the Agency's decision on the most appropriate way to approach this issue within the context of this Report to Congress. At a minimum, the report is likely to characterize what the impacts might be and where, or how much, cause for concern exists.

Discussion Session 1: Characterizing Pathogens and Pollutants

This discussion session began with a more in-depth review of the proposed research questions for the topics of pathogens and pollutants present in sewer overflows. Except where otherwise noted, the statements in this summary reflect the opinions of individual experts that participated in the workshop and not the opinions of EPA. Key questions raised to the group included:

- *What pathogens and pollutants are present in sewage overflows?*
- *What illnesses are associated with these pathogens and pollutants?*
- *Which pathogens and pollutants cause the most serious health effects?*
- *Who is likely to have information or data regarding the constituents in sewage and their health impacts?*

Responses to each of these questions follow in the subsequent sections. During this session, the facilitator reminded the group that CSOs and some SSOs have a substantial storm water component, which expands the universe of potential pathogens and pollutants beyond those in human waste.

What pathogens and pollutants are present in sewage overflows?

Below is a list of pathogens Marasco Newton Group researchers presented to the group as those expected to be present in sewage overflows, based on a preliminary literature review. Discussions related to specific types of pathogens follow.

Pathogens and Pollutants Expected to Be Present in Sewer Overflows.

Parasites (Protozoa)

Pathogen	Symptoms, Illnesses Caused
<i>Cryptosporidium parvum</i>	Gastroenteritis: diarrhea, loose or watery stools, stomach cramps, upset stomach, and a slight fever; children and pregnant women are more susceptible to dehydration as a result of <i>Cryptosporidium</i> ; can lead to life-threatening disease in those with weakened immune systems; there is no effective treatment.
<i>Cyclospora cayetanensis</i>	Cyclosporiasis: watery diarrhea, with frequent, sometimes explosive, bowel movements, loss of appetite, substantial loss of weight, bloating, increased gas, stomach cramps, nausea, vomiting, muscle aches, low-grade fever, and fatigue; not considered contagious; antibiotic treatment available; lasts a few days to a month; relapses possible.
<i>Entamoeba histolytica</i>	Amebiasis: loose stools, stomach pain, and stomach cramping; Amoebic dysentery is a more serious form of Amebiasis; very rarely invades the liver and causes an abscess, even more rarely invades other body parts such as the lungs or brain; difficult to diagnose; antibiotic treatment is available; contagious.
<i>Giardia lamblia</i>	Diarrhea, loose or watery stool, stomach cramps, and upset stomach; may lead to weight loss and dehydration; children and pregnant women more susceptible to dehydration; very contagious; lasts 2–3 weeks in otherwise healthy persons; prescription drugs are available.
<i>Naegleria fowleri</i>	<i>Naegleria</i> infection [also called primary amebic meningoencephalitis (PAM)]: headache, fever, nausea and vomiting, stiff neck, confusion, lack of attention to people and surroundings, loss of balance and bodily control, seizures, and hallucinations are signs and symptoms of infection; infection is very rare; without immediate treatment, death occurs within 10 days; not contagious.
<i>Balantidium coli</i>	Dysentery, intestinal ulcers, abdominal pain, weight loss; most cases asymptomatic; treatment is available.
<i>Isospora belli</i> and <i>Isospora hominus</i>	Intestinal parasites, gastrointestinal infection.
<i>Toxoplasma gondii</i>	Toxoplasmosis: rare among those with healthy immune systems; flu-like symptoms; those with weakened immune systems can become very ill, resulting in damage to the eye or brain; infants infected in the womb can be born with mental retardation or other serious complication; treatment is rarely needed in healthy persons; drugs are available.

Bacteria

Pathogen	Symptoms, Illnesses Caused
<i>Campylobacter</i>	Gastroenteritis, Campylobacteriosis: diarrhea, cramping, abdominal pain, fever, diarrhea may be bloody and can be accompanied by nausea and vomiting; most recover within 2 to 10 days; some may develop arthritis; one in every 1,000 reported campylobacteriosis cases leads to Guillain-Barré syndrome (a rare disease that affects the nerves).
<i>Enterococcus spp.</i>	Urinary tract infections, bacteremia, subacute endocarditis; wound infections and intrabdominal abscesses are generally polymicrobial; meningitis.
<i>E. coli</i> 0157:H7	Gastroenteritis: severe bloody diarrhea or nonbloody diarrhea, abdominal cramps; most with only diarrhetic symptoms fully recover; 2% to 7% of children and elderly infected with <i>E. coli</i> , may develop hemolytic uremic syndrome, in which the red blood cells are destroyed and the kidneys fail; 33% of persons with hemolytic uremic syndrome have abnormal kidney function many years later, and a few require long-term dialysis, a smaller percentage of persons with hemolytic uremic syndrome develop high blood pressure, seizures, blindness, paralysis, and the effects of having part of their bowel removed.
<i>Vibrio cholerae</i>	Cholera: infection of the intestine, acute diarrhea; one in 20 infected persons has severe disease characterized by profuse watery diarrhea, vomiting, and leg cramps leading to dehydration and shock.
<i>Leptospira</i>	Leptospirosis: high fever, severe headache, chills, muscle aches, and vomiting, and may include jaundice (yellow skin and eyes), red eyes, abdominal pain, diarrhea, or a rash; if the disease is not treated, the patient could develop kidney damage, meningitis (inflammation of the membrane around the brain and spinal cord), liver failure, and respiratory distress; in rare cases death occurs.
<i>Pseudomonas dermatitis / Folliculitis</i>	Dermatitis.
<i>Pseudomonas aeruginosa</i>	Swimmer's Ear.
<i>Salmonella</i>	Salmonellosis: fever, abdominal cramps, and diarrhea (sometimes bloody); most with diarrhetic symptoms completely recover; a small number of persons will develop Reiter's syndrome leading to pains in their joints, irritation of the eyes, and painful urination; Reiter's syndrome can last for months or years, and can lead to chronic arthritis.
<i>Salmonella Typhi</i>	Typhoid fever: fever, weakness, or stomach pains, headache, or loss of appetite; rash of flat, rose-colored spots; vaccines are available.
<i>Shigella</i>	Bacterial dysentery, Shigellosis: diarrhea (often bloody), fever, and stomach cramps.

Pathogen	Symptoms, Illnesses Caused
<i>Yersinia</i>	Yersiniosis: symptoms in children are fever, abdominal pain, and diarrhea, which is often bloody; in adults, right-sided abdominal pain and fever may be the predominant symptoms, and may be confused with appendicitis.

Viruses

Pathogen	Symptoms, Illnesses Caused
Hepatitis A	Jaundice, fatigue, abdominal pain, loss of appetite, nausea, diarrhea, fever; there is no long-term infection; 15% of those infected may have prolonged symptoms lasting up to nine months; those who have had the disease once may never become infected again; vaccines are available.
Hepatitis B	Jaundice, fatigue, abdominal pain, loss of appetite, nausea, vomiting, joint pain, cirrhosis and liver cancer (lead to 4000–5000 deaths in the U.S. each year); chronic infection occurs in 90% of infants infected at birth, 30% of children infected prior to age 5, and 6% of persons infected after age 5; vaccines are available.
Adenoviruses	Viral gastroenteritis, vomiting, diarrhea.
Rotavirus	Viral gastroenteritis, vomiting, diarrhea.
Enteroviruses, such as coxsackieviruses and echoviruses	Viral (aseptic) meningitis: fever, severe headache, stiff neck, bright lights hurt the eyes, drowsiness or confusion, and nausea, and vomiting.
Calicivirus	Viral gastroenteritis: vomiting, diarrhea; infants, young children, and persons who are unable to care for themselves, such as the disabled or elderly, are at risk for dehydration from loss of fluid; immunocompromised persons are at risk for dehydration because they may get a more serious illness, with greater vomiting or diarrhea.
Astrovirus	Viral gastroenteritis: vomiting, diarrhea; infants, young children, and persons who are unable to care for themselves, such as the disabled or elderly, are at risk for dehydration from loss of fluid; immunocompromised persons are at risk for dehydration because they may get a more serious illness, with greater vomiting or diarrhea.
Norwalk virus and Norwalk-like viruses	Viral gastroenteritis: vomiting, diarrhea; infants, young children, and persons who are unable to care for themselves, such as the disabled or elderly, are at risk for dehydration from loss of fluid; immunocompromised persons are at risk for dehydration because they may get a more serious illness, with greater vomiting or diarrhea.
Poliovirus	Polio: sore throat, fever, nausea, vomiting, abdominal pain, constipation, flu-like symptoms, stiffness in the neck, back, and legs.

Helminths

Pathogen	Symptoms, Illnesses Caused
<i>Ascaris</i> (intestinal roundworm)	Ascariasis: most people have no symptoms; abdominal pain, difficulty breathing, and blocked intestines.
<i>Ancylostoma</i> (hookworm)	Hookworm infections: rash; light infection may cause no symptoms; heavy infection can cause anemia, abdominal pain, diarrhea, loss of appetite, and weight loss; heavy, chronic infections can stunt growth and mental development.
<i>Schistosoma</i>	Cercarial dermatitis (Swimmer's Itch): rash or itchy skin; fever, chills, cough, and muscle aches can begin within 1–2 months of infection; rarely, eggs are found in the brain or spinal cord and can cause seizures, paralysis, or spinal cord inflammation; for people who are repeatedly infected for many years, the parasite can damage the liver, intestines, lungs, and bladder.
<i>Trichuris trichiura</i> (human whipworm)	Most frequently asymptomatic; heavy infections, especially in small children, can cause gastrointestinal problems (abdominal pain, diarrhea, rectal prolapse) and possibly growth retardation.

Metals and other pollutants

Pollutant	Possible Health Effects
Lead	Nerve degeneration, including hearing loss, peripheral neuropathy (causing tingling or muscle weakness in fingers, wrists, or ankles), and brain damage; kidney damage; increased blood pressure; blood anemia; lowered immune system function; reduced sperm count and motility; miscarriage, stillbirth, premature birth, and reduced birth weight; colic and impaired mental and physical development (in children).
Mercury	Permanent brain damage, personality changes (irritability, shyness, nervousness), tremors, changes in vision (constriction of the visual field), deafness, muscle incoordination, loss of sensation, and difficulties with memory.
Copper	Dizziness, headaches, diarrhea, and liver and kidney damage.
Zinc	Stomach cramps, nausea, vomiting, anemia, pancreas damage, and reduced blood levels of high density lipoprotein cholesterol (the good form of cholesterol).
PCBs	Acne-like skin conditions (chloracne) and rashes, liver damage (PCB exposures in the general population are not likely to result in skin and liver effects), anemia; liver, stomach, and thyroid gland injuries; changes in the immune system; behavioral alterations; and impaired reproduction.
Pesticides	Liver and kidney damage, elevated risk of cancer.

Specific comments on the above tables from workshop participants follow:

- *Microsporidia* should be included in this discussion. These pathogens have a low infectious dose (on the order of 1–100 organisms) and are resilient in the environment because of their durable oocysts.
- Remove *Naegleria fowleri*, *Balantidium coli*, *Leptospira*, and Hepatitis B from the list. These are either absent in human waste or not waterborne (*Note: some of these could be contributed to the storm water component of CSOs*).
- Include all pathogenic *E. coli*, instead of just *E. coli* 0157:H7.
- *Vibrio cholerae* is rare, but still an issue in shellfish.
- Hepatitis E virus was discussed as an emerging waterborne disease with long-term health effects.
- Other pathogens to research for the preliminary list are: *Isospora belli* and *Isospora hominus*, *Ancylostoma*, *Baylisascaris*, *Echinococcus*, *Enterobius*, *Taenia solium*, *Toxocara*, *Francisella tularensis*, and Hepatitis C.
- Because viruses rely on suspended particles for transport in water, the concentration of viruses in a water body increases with the concentration of suspended particles (*Note: It is important to understand that severity of illness associated with viruses is not related to the number of organisms ingested. Any infectious dose, large or small, will result in a full-blown viral infection. The number of organisms ingested does relate to the severity of infection with bacteria and parasites*).
- The Pretreatment and Storm Water Programs of the CWA are supposed to address sources of metals. Some POTWs employ a metal scan to meet their permit limits, but this process would not apply to sewer overflows. Wastewater treatment plants (WWTPs) remove much of the copper, but zinc tends to pass through the treatment process. CSOs and SSOs may cause elevated levels of zinc, copper, arsenic, and polycyclic aromatic hydrocarbons (PAHs) in receiving waters. Lead has been a problem in the past, but its significance has diminished in recent years with respect to sewer overflows.
- Separate the PAHs from synthetic organics.
- Add arsenic to the list of metals. This can lead to skin problems. One expert cited a study that showed storm water to contribute 80 to 90 percent of the arsenic load to receiving waters.
- The relevancy of pharmaceuticals and personal care products (PPCPs) to this study effort is questionable because these constituents presently are not removed by conventional wastewater treatment processes. Because of this, CSOs and SSOs are not likely to contribute additional loadings over treated effluent. The majority of suspected human health threats associated with PPCPs are long-term and result from ingesting water; however, specific effects are largely unknown. One way to estimate these loadings is to look at sales figures for these products. The PPCP discussion should not be limited to public health, as there are important potential environmental and animal issues relating to antibiotic resistance and hormones.

- Fungi was discussed as another illness-causing agent that can result from sewer overflows, primarily in basements. Symptoms can include neural and dermal problems. In an example case in Cleveland, Ohio, black mold specifically affected infants. In southern California, basement backups following the Northridge earthquake, January 17, 1994, resulted in many reports of toxic molds.
- The majority of WBDs in the United States are never attributed to a specific etiologic agent. Even when proper tests are performed, timing is critical for correctly diagnosing the causative agents.
- Pathogen presence and loads are quite variable by region and are related to the demographic groups that contribute to the system. For example, effluents are more likely to contain the Hepatitis A virus in areas of the United States near the border with Mexico. Also, the City of Boston experiences different loadings during the academic year, when students populate the city's many universities.

What illnesses are associated with these pathogens and pollutants?

Specific comments:

- The group had no major amendments to the symptoms and illnesses presented in the table of pathogens.
- The study should acknowledge that in the majority of cases, the etiologic, or disease-causing, agent is not identified. Most of these cases are self-medicated. In addition, expensive diagnoses typically are not encouraged by health care providers. The group noted that in otherwise healthy populations, *Cryptosporidium*, *Giardia*, and *Shigella* are generally self-curing.

Which pathogens and pollutants cause the most serious health effects?

Specific comments:

- A national ranking of pathogens might be misleading, due to variability of site-specific factors, such as climate and population. Moreover, the particular pathogen responsible for an outbreak will be considered of paramount importance in that given community. Ranking would not capture this variability, since outbreaks are discovered only after the fact and the illness-causing agent is seldom the same.
- The report should distinguish between the severity (both short- and long-term) and probability of contracting a particular illness. An example from the realm of food-borne illness illustrated this point. Toxoplasmosis is the most costly food-borne illness because it leads to birth defects and requires long-term care and treatment for patients, in spite of the fact that it is quite rare. *E. histolytica* is an example of an extremely severe waterborne protozoal pathogen.

- Distinguish between pathogens that are immediately infectious and those that require hosts to reach an infectious stage. Pathogenic helminths, including *Baylisascaris*, *Toxocara*, and *Enterobius*, require an external incubation before they pose a threat to humans. Tapeworms are immediately infectious and include *Taenia solium* (pork tapeworms), *H. nana*, and *Echinococcus*. Again, the group stressed that local demographic and climatic conditions influence the presence of pathogens.
- Many parasitic illnesses are asymptomatic. In other cases, the severity depends not only on the pathogenic organism, but also the number of organisms ingested. For example, *Baylisascaris* can be severe if exposed to many organisms.
- The most important bacteria, in terms of severity and incidence, are *Salmonella*, pathogenic *E. coli* (non-pathogenic *E. coli* also occur in sewage), and *Shigella*. One expert suggested the addition of *Francisella tularensis* to the list of bacteria that can cause WBDOS.
- Provide a species name for *Enterococcus*. The rationale is that every animal carries some species of *Enterococcus*, not all of which are infectious to humans.
- The protozoal pathogens could be ranked as follows to characterize their relative importance on the national public health spectrum:

Ranking	Parasite	Likelihood of exposure	Severity
1	<i>Cryptosporidium parvum</i>	High – moderate	Moderate – low
2	<i>Giardia lamblia</i>	Moderate	Moderate
3	<i>Entamoeba histolytica</i>	Low	High
3	<i>Toxoplasma gondii</i>	Low	High

- Some types of pathogens are important contributors to health impacts and are more likely to cause an outbreak, while others may have long-term exposure consequences.
- The viral pathogens present in sewage can be ranked in general terms of how much concern should be given by the public health community. The list is as follows:

Ranking	Viral agent	Likelihood of exposure	Severity
1	Norwalk-like and Caliciviruses	High – moderate	Moderate – low
2	Hepatitis A	High along the U.S.-Mexico border	High – moderate
3	Astrovirus and Rotavirus	Low	Moderate
4	Enteroviruses	Low	High
5	Poliovirus	Low	High
6	Hepatitis C	Low	High

- Metals are not a significant health concern arising from sewer overflows, as most heavy metals are removed through pretreatment and lead abatement.
- Since PCBs are highly site-specific, their importance on a national scale is minor. The fish in New York’s Onondaga and Madison Lakes have much lower levels of heavy metals today than in the past. Another participant felt that benthic macroinvertebrates are the organisms most drastically affected by metals in sewer overflows, so that while metals are not likely to cause a WBDO, they are an important environmental issue.
- Pesticides are likely an issue of greater public health concern than metal. Pesticide pollution results primarily from non-point sources, so the contribution to the CSO/SSO impacts is largely one through storm water. One possible approach for this report would be to look at communities with a history of deposition from industrial pesticide manufacturing and investigate the tendency for bioaccumulation. Some pesticides introduced into municipal waste streams would be removed with the solids, degrading over time.

Who is likely to have information or data regarding the constituents in sewage and their health impacts?

Specific comments:

- The MetroGro program in Madison, Wisconsin, may have data on pathogens and pollutants in biosolids.
- Because additional monitoring and treatment technologies require significant financial commitments, areas historically impacted by contaminated water will likely be more proactive in taking steps to protect human health. Examples might include southern California, Florida, and the Gulf Coast, all areas with vibrant beach-related tourism. Other communities to target for information, may be where public perception of risk is high, as this tends to be a catalyst for action.

Additional comments on Discussion Session 1:

- Bacteria are the most commonly used indicator of sewage contamination. Most indicators were initially developed to determine whether wastewater treatment technologies were functioning, not specifically to protect human health.
- Bacterial indicators work reasonably well in overflow situations because of the associated high bacterial loadings. One question that arose was whether to measure concentrations at the overflow point or in the receiving water, as dilution is not uniform for in all receiving waters.
- With respect to viruses, the relative concentration in a water body factors into the risk of infection. Because viral counts are typically low, samples often must be concentrated to enable detection. This makes the use of viral indicators difficult.
- Some jurisdictions use rainfall as an indicator of contamination. For example, a rainfall event greater than 0.5 inches might result in temporary shellfish bed closures. The same criteria might be used for beach closures, but the frequency and duration would vary with population, climate, and watershed characteristics.

Discussion Session 2: Pathways of Exposure

Following the discussion of the research questions, the experts were asked to comment on the data sources identified to date to answer the proposed research questions. Key questions included:

- *Aside from CSOs and SSOs, what other sources of pathogens might people come in contact with?*
- *What are the potential exposure pathways?*
- *Which populations face the greatest exposures?*
- *Which populations are the most sensitive?*
- *Where are we likely to find information about pathways and exposures?*

Responses to each of these questions follow in the subsequent sections.

Aside from CSOs and SSOs, what other sources of pathogens might people come in contact with?

Specific comments:

- Experts confirmed the finding from the literature review that sediments in CSSs can harbor pathogens and act as a source when flushed during wet weather events.
- On-site treatment systems (e.g., septic tanks) also are potential contributors of pathogens and should be included in a discussion of pathogen sources. While properly sized septic systems can provide the best treatment possible in the correct

soil and groundwater settings, many U.S. communities have near-urban densities of developments served by septic systems. In some cases, high water tables or improper siting and maintenance lead to contamination of surface and storm water. A participant commented that investigations of septic systems in the City of Malibu, California, a locale with 1,200 to 1,500 beachfront homes, have found high failure rates among the on-site systems.

- Truck spills or crashes are another small, but potentially important source of pathogens. Incidents of this type are widespread and occur primarily in urban drainage systems.
- Background levels of contamination are an issue. For example, in Birmingham, Alabama, a mass balance model showed that sewer overflows contribute only 2 to 3 percent of the total annual pathogen load.
- Because wet weather SSOs have a large storm water component, one expert stated that these SSOs and CSOs have largely the same constituents.
- On a related note, storm water has been shown to contribute a significant amount of the total pathogen load to a given water body. In light of this fact, some participants commented that properly managed CSSs sometimes perform better than separate systems. Separate systems also may be more expensive to operate because storm water requires treatment in most municipalities. Some southern California cities have recently undertaken efforts to redirect dry weather storm water flows to WWTPs from April to October.
- The report should attempt to distinguish between human and non-human (e.g., wildlife, animal feeding operations) sources of pathogens, as this distinction may lead to better understanding of loadings within the watershed. This is not an easy distinction to make. One expert reported that three samples from the 1993 Cryptosporidiosis outbreak in Milwaukee, Wisconsin, indicated a human, rather than bovine, genotype. The participant recommended that efforts for this report focus on the human pathogen sources found in sewage overflows.
- The draft literature review never explicitly states that the principal source of the pathogens of concern is the human intestine, meaning that one could determine the pathogens present in sewage by understanding the baseline level of illness in the population served, at least for the non-storm water component. In order for an outbreak to occur, a previously infected population must introduce the pathogens into the sewer system prior to a sewer overflow. Atlanta was cited as an example of a city with a large number of people testing positive for antibodies to *Cryptosporidium*, implying some level of residual contamination.

What are the potential exposure pathways?

Specific comments:

- Waterborne pathogens generally can be classified to describe relative resistance both in the environment and to treatment processes. Under such a system, bacteria

have the least resistance, viruses are moderately resistant, and parasites are generally the most resistant.

- The presence of air generally does not affect pathogen survival. Dryness is the largest stressor for the pathogens of concern.
- Most of the pathogenic organisms discussed in the earlier sessions can be transported by any of the potential pathways.
- Risks from recreational exposures vary, depending on who is swimming (e.g., healthy adults, children, pregnant women, immunocompromised persons), what organisms are being shed (both by the swimmers and within the watershed), and the underlying baseline from other pathogen sources in the watershed.
- Shellfish concentrate pollutants to levels much higher than the ambient water body; therefore, consumption of shellfish harvested from contaminated waters exposes humans to an increased risk of infection by waterborne pathogens.
- An issue raised on this subject was the difficulty in measuring the exposures of children playing in urban creeks and drainage systems. Exposures would increase with proximity to outfalls and contaminated sediments.
- Sewer overflows might contaminate irrigation streams, which are used to wash produce in the fields. Water used for irrigation would fall well below standards for drinking water. Contaminated produce can cause food-borne outbreaks.
- One expert commented that many CSO communities receive the bulk of their annual rainfall during summer months, increasing the likelihood of recreational exposures. Controlling overflows will have a significant benefit for these communities.

Which populations face the greatest exposures?

Specific comments:

- WWTP workers are not necessarily good indicators of the human health threats associated with sewage for a number of reasons. One participant commented that many of the studies of these groups have not used a valid control group and that other studies have failed to show an increased health threat to WWTP workers. An explanation for this is that over the course of their employment, workers build up immunity to many of the pathogens present in the work environment. New workers, on the other hand, might be a reasonable group to use as sentinels in a future study.
- Children probably face the greatest recreational exposures due to the fact that they are most likely to spend time with their heads immersed in water.
- Adults (specifically males between the ages of 15 and 45) consume the most shellfish and therefore face the greatest exposure via this route, although the data supporting this claim were called into question.

- Data on health threats to subsistence fishers are not well established; however, this topic is currently being investigated by researchers at The Johns Hopkins University.

Which populations are the most sensitive?

Specific comments:

- The human health threats associated with sewage increase along with the increasing numbers of people contributing to the system. For example, individuals are less likely to become ill from exposure to their own, or their family's, sewage. Basement backups that occur closer to the WWTP are likely to contain more people's wastes and therefore could be more hazardous to the occupant.
- Some of the newer generation anti-retroviral drugs currently being used to treat patients with HIV also have been shown to abate *Cryptosporidium*. Though some pathogens will likely have a greater impact on immunocompromised populations, treatment options influence their particular sensitivity.

Where are we likely to find information about pathways and exposures?

Specific comments:

- A study from Madison, Wisconsin, compared illness among pool swimmers, lake swimmers, and people visiting lake beaches but not swimming.
- Many illnesses contracted while swimming at beaches appear to be caused by viral agents. Most untreated viral illnesses will resolve themselves within five days. As a result, these will be difficult to measure.
- An important consideration is that the majority of the recreational exposures reported in the CDC *Surveillance Summaries* occur in chlorinated swimming pools and are therefore not relevant to the study effort. On a related note, in many WBDs, swimmers themselves appear to be the source of the contamination. A range of factors, from personal hygiene to children in diapers, can influence the contributions of bathers to pathogen loads.

Discussion Session 3: Open Discussion Session

Based on the discussion from the morning and afternoon sessions, time was allotted to address any outstanding issues or questions, comment on the framing of the study within the context of the 2003 Report to Congress, and revisit any subjects requiring clarification.

Given all of the potential pathogen sources within a watershed and the expense involved in monitoring and infrastructure improvements, where will expenditures have the greatest benefit from a public health perspective?

Specific comments:

- Local community concerns and priorities should dictate where large capital expenditures are made. Drinking water protection is probably the first priority, though recreation and fishing are other major issues for certain communities.
- Treatment technologies should focus on the most resistant, difficult to treat pathogens. In doing so, other pathogens will likely be removed. Ultraviolet treatment may be a possible solution, but is still prohibitively expensive in many applications and may be inappropriate for some satellite collection systems.

Thursday August 15, 2002

Welcome and Structure of Day Two

Ms. Manning split the group into two breakout groups charged with discussing different aspects of the study and reporting back to the larger group. One group discussed the significance of the CSO/SSO problem, while the other was asked to comment on methods for conducting this type of investigation. The entire group then further discussed each topic, ensuring that all experts had the opportunity to discuss both. The summaries of each breakout session and the subsequent discussion follow.

Breakout Session A: Significance of the CSO and SSO Problem

During this breakout session, the group discussed the actual significance of CSOs and SSOs in broader public health terms. The questions posed to this group included:

- *Are illnesses associated with sewage a major public health threat?*
- *What are the relative contributions of CSOs and SSOs?*
- *Would elimination of CSOs and SSOs result in a substantial health benefit?*
- *How do the human health threats from CSOs and SSOs compare to other environmental health threats?*

Responses to each of these questions follow in the subsequent sections.

Are illnesses associated with sewage a major public health threat?

Specific comments:

- This group felt that pathogens present in sewage do represent a significant public health threat. This basic fact supports the rationale for wastewater treatment.

What are the relative contributions of CSOs and SSOs?

Specific comments:

- Though accurate national estimates do not exist, limited data suggest that CSOs and SSOs contribute only a small portion of the total pathogen load on a national scale.
- Few outbreaks are known to have resulted from sewer overflows. One participant said that some evidence suggests that CSOs may have contributed to the Milwaukee *Cryptosporidium* outbreak. Other outbreaks in Cabool, Missouri, (pathogenic *E. coli*) and Idaho (*Shigella*) were said to have resulted from sewer overflows.

Would elimination of CSOs and SSOs result in a substantial health benefit?

Specific comments:

- Completely eliminating CSOs and SSOs would have a real public health benefit. However, under current measuring and tracking systems, it is unlikely that this elimination would result in a *measured* reduction in waterborne illness because current tracking mechanisms do not adequately assess the baseline. This may be due to gaps in the monitoring system (such as voluntary reporting requirements) and the myriad of exposures to the same pathogens.
- Regional and cultural differences can influence the likelihood of detection. For example, a community where many rely on bottled water for drinking is less likely to report contamination.

How do the health threats from CSOs and SSOs compare with other environmental health risks?

Specific comments:

- Impacts from CSOs might be easier to pinpoint because most outfall locations are known. Measuring impacts from SSOs would be more difficult because they occur throughout the sewer system.

Breakout Session B: Options for the Current Study

During this breakout session, the group discussed ways to estimate the national illness burden resulting from CSOs and SSOs. Some questions included:

- *Who would you interview to gather data?*
- *What other sources might be used?*
- *How would the available data be combined to create an estimate?*
- *What product or information would be the most useful to improve EPA's understanding of this issue?*

Responses to each of these questions follow in the subsequent sections.

Who would you interview to gather data?

Specific comments:

- The current data are severely limited. Existing cases are reported to physicians or public health departments, but generally are recorded as cases of gastrointestinal illness without specific source attribution.
- Many communities regularly measure ambient water quality criteria. One thought was to identify municipalities with advanced monitoring programs.
- Another approach might be to investigate communities with a history of chronic CSO and SSO problems to find out what kinds of public health impacts have been reported and linked to the overflows.
- The best sources of data would be state and local public health departments. To put this in perspective, however, members of the group also stated that sewage-related illnesses typically are not a high priority for local public health personnel, unless the community has instituted a specific study or had a history of acute impacts. Other potential sources of information include health maintenance organizations (HMOs), universities, state departments of environmental quality, regular resource users (e.g., lifeguards, swimmers, or surfers), and organizations that track school absenteeism.

What other sources might be used?

Specific comments:

- Some data exist on outbreaks linked to contaminated shellfish.
- EPA could investigate the illness burden of new, therefore previously unexposed, sewage treatment workers who have not developed resistance to pathogens in the workplace. A national company might track this information for new employees. Inexperienced plumbers would likely face many of the same health threats.

- Much “grey” literature (e.g., meeting symposia) exists, but many papers presented will not be peer reviewed.

How would the available data be combined to create an estimate?

Specific comments:

- The individual, local constituents of overflows are largely unknown. Even where these are known, exposures and dose/response relationships are not. Thus, any modeling for this report will prove difficult.
- Investigate the percentage of pathogens removed by conventional POTWs, and use this figure to estimate the loadings from CSOs and SSOs.
- Some proxies for waterborne illness include absenteeism (from work and school), sales of antidiarrheal medicines, and reportable diseases. Most monitoring systems are “passive” systems, meaning they rely on voluntary reporting. Participants stated that so called “active” surveillance systems, consisting of interviews and other investigations, typically return more robust data.
- Another possible approach is to find a community with some good data and articulate the missing data elements. Begin by describing the site-specificity of the community data, then extrapolate to characterize the potential health threats, while explaining where gaps exist. One of the most helpful outcomes of this study might be to identify the necessary data points and describe those that have available data.

What product or information would be the most useful to improve EPA’s understanding of this issue?

Specific comments:

- Genetic fingerprinting of pathogens is improving and has the potential to improve waterborne disease surveillance.
- Sentinel populations of shellfish placed near CSO outfalls could be used to study accumulation time for certain pathogens of concern.
- A defensible estimate of human health impacts would require reliable data on loadings, uses and exposures, and dose/response relationships.
- Monitoring WWTP influents would improve knowledge of the constituents in sewage overflows. Researchers could then attempt to trace the constituents to specific public health impacts. The costs associated with identifying specific pathogens and their sources are still considerable, which makes this option less attractive.

General Discussion

After the entire group had reconvened and discussed the breakout topics, Ms. Manning posed some additional questions for discussion. These are described and summarized below.

What is the extent of waterborne disease in the United States?

Specific comments:

- Food-borne illness, not sewage, is believed to be the largest cause of gastrointestinal (GI) cases in the United States. Estimates from the participants suggested that food-borne illnesses probably make up somewhere on the order of 75 percent of the national GI cases. Person-to-person transmission is the next largest cause, contributing perhaps 10 to 15 percent of the GI cases. Zoonoses (diseases carried by animals that can be transmitted to humans) and drinking water probably account for one percent, with CSOs and SSOs likely responsible for only a fraction of one percent.
- From a health burden perspective, the greatest public health impacts from sewage will be diffuse, but the cumulative costs great. This cost figure includes the impacts of missed work or school days plus the cost of over-the-counter antidiarrheal medicines.

How does underreporting affect our knowledge of waterborne illness?

Specific comments:

- Probably only 10 percent of the WBDOs are reported in the existing data management systems. One participant made a point that echoed a finding from CDC's *Surveillance Summaries*, that the number of WBDOs reported increases as more personnel and resources are made available to investigate outbreaks.
- Most outbreaks reported are extreme events which ignore the widespread, non-reported illnesses that make up the majority of the national impacts. Studying waterborne illness based on outbreaks is akin to studying meteorology based solely on hurricanes.

How are waterborne illnesses tracked?

Specific comments:

- No reliable, national data set exists for making the connection between sewer overflows and public health impacts because neither the overflows nor the health impacts are measured and reported consistently. Regardless of controls used for CSO and SSO abatement, the existing reporting and tracking infrastructure is unlikely to register reductions in national waterborne disease.

How are human health threats mitigated, reported, and communicated to the public?

Specific comments:

- Several disincentives for public notification of human health threats exist at the local level. Sewer overflows present a public relations problem. Warnings of public health threats can send the message that parks or beaches are unsafe, creating conflicts with local elected officials and park personnel. Also, an effective notification program requires a substantial resource commitment that not all communities can make. Even when warnings are posted, they are often ineffective in communicating the real threats to the resource users. A warning system similar to that used to describe air quality indices may be useful for recreational water quality and might include actual monitoring data, relation of measured water quality to standards, or another metric for conveying the potential health threats.

Final Comments and Next Steps

Comments

- CSOs and SSOs are not solely public health threats, but must be viewed as nutrient loadings with other ecological impacts. This is one of EPA's stated goals for the 2003 Report to Congress.

Next Steps

- The report team thanked the participants for their work during the two-day meeting. A summary of the discussions will be created and circulated for comment to workshop participants. The 2003 Report to Congress will include this summary in an appendix. The anticipated spring 2003 stakeholder meeting will give the interested participants, as well as a larger group of stakeholders, the opportunity to review and comment on EPA's preliminary findings from the report effort.

Appendix A: Attendee List

Expert Participants

<u>Name</u>	<u>Affiliation</u>
Rebecca Calderon	U.S. EPA
Dean Cliver	University of California, Davis
Alfred Dufour	U.S. EPA
Kim Fox	U.S. EPA
Dennis Juranek	Centers for Disease Control and Prevention
Peter Moffa	Brown and Caldwell
Jack Petralia	Independent Consultant, CA State Water Resources Control Board
Bob Pitt	University of Alabama
Kellogg Schwab	Johns Hopkins University, Bloomberg School of Public Health

Observer Participants

<u>Name</u>	<u>Affiliation</u>
Susan Adair	Tetra Tech
Kevin Bell	U.S. EPA
Linda Boornazian	U.S. EPA
Kevin DeBell	U.S. EPA
Greg Frey	Marasco Newton Group
Frank Greenland	Northeast Ohio Regional Sewer District
Jim Hanlon	U.S. EPA
Ann Johnson	U.S. EPA
Linda Manning	Marasco Newton Group
George Martin	Greenwood Metropolitan District
Michele Merkel	Environmental Integrity Project
Julia Moore	Limno-Tech, Inc.
Eileen O'Neill	Water Environment Federation
Heather Pope	Marasco Newton Group
Bruce Pumphrey	U.S. EPA
Nancy Stoner	Natural Resources Defense Council
Lee Ting	Marasco Newton Group
Arthur Totten	U.S. EPA
Betsy Valente	Limno_Tech, Inc.
Nancy Wheatley	Water Environment Federation
Clyde Wilber	CSO Partnership
David Williams	East Bay Municipal Utility District

Appendix B: Agenda

Combined Sewer Overflow (CSO) and Sanitary Sewer Overflow (SSO)

Public Health Impacts Experts Meeting

August 14-15, 2002

**Marasco Newton Group
2425 Wilson Boulevard, 2nd Floor
Arlington, Virginia**

Purpose and Objectives: bring together recognized experts in the field of public health to:

- Fully elucidate the issues and the magnitude of those issues associated with health impacts of combined sewer overflows (CSOs) and sanitary sewer overflows (SSOs);
- Review and supplement data and information sources identified to date; and
- Garner input for the methodology for gathering and analyzing the information and data for the 2003 report.

Wednesday August 14, 2002

9:00 – 9:30	Welcome <i>Jim Hanlon – Director, Office of Wastewater Management, Office of Water, U.S. EPA</i> <i>Linda Boornazian – Director, Water Permits Division, Office of Water, U.S. EPA</i>
9:30 – 9:45	Agenda Review and Logistics <i>Linda Manning – Marasco Newton Group, Facilitator</i>
9:45 – 10:30	Overview of the 2001 and 2003 Reports to Congress <i>Kevin DeBell, U.S. EPA</i> <i>Mr. DeBell will provide an overview of the legislative, regulatory, and programmatic background to the CSO/SSO question, and an overview of the major findings of the 2001 Report to Congress, <u>Implementation and Enforcement of the Combined Sewer Overflow Control Policy</u>. Mr. DeBell also will present a brief overview of the proposed methodology and key research questions for the 2003 Report to Congress, describing the context for the public health component.</i>
10:30 – 10:45	Break

10:45 – 11:15

Overview of Proposed 2003 Report Methodology

Greg Frey, Marasco Newton Group

Mr. Frey will review with the group the research questions and methodology developed to date for answering the key public health questions. Key research questions include:

- *What is the extent of waterborne disease in the United States? How are illnesses tracked?*
- *Are illnesses associated with sewage contact a major public health threat?*
- *How are the risks to illnesses associated with sewage currently communicated, prevented, and mitigated? Are these measures adequate?*

Questions of clarification will be asked in this session only as a more detailed session focused on methodology will follow on Day Two.

11:15 – 12:00

Discussion Session: Characterizing Pathogens and Pollutants

This discussion session will begin with a more in-depth review of the proposed research questions for each topic. Key questions that will be raised to the group include:

- *What pathogens and pollutants are present in sewage overflows?*
- *What illnesses are associated with these pathogens and pollutants?*
- *Which pathogens and pollutants cause the most serious health effects?*
- *Who is likely to have information/data regarding the constituents in sewage and their health impacts?*

12:00 – 1:30

Lunch (served at the Marasco Newton Group facility)

1:30 – 2:45

Discussion Session: Pathways of Exposure

Following the discussion of the research questions, the group will be asked to assess the data sources identified to date to answer the proposed research questions. Key questions may include:

- *Aside from CSOs and SSOs, what other sources of sewage might people come in contact with?*
- *What are the potential exposure pathways?*
- *Which populations face the greatest exposures?*
- *Which populations are the most sensitive?*
- *Where are we likely to find information about pathways and exposures?*

2:45 – 3:00

Break

3:00 – 4:00

Discussion Session: Incidence and Prevention of Illness

During this session, the group will discuss the actual incidence, tracking, and prevention of waterborne illnesses. Key questions may include:

- *What reporting and tracking mechanisms exist for waterborne disease?*
- *What reporting and tracking mechanisms exist for other public health outbreaks?*
- *What cost information is available about these outbreaks?*
- *How are risks communicated, prevented, and mitigated?*

4:00 – 4:45	Open Discussion <i>Based on the discussion from the morning and afternoon sessions, this time will be allotted to address any outstanding issues or questions, comment on the framing of the study within the context of the 2003 Report to Congress, and revisit any subjects requiring clarification.</i>
4:45 - 5:00	Closing Remarks
5:00 – 6:30	Reception

Thursday August 15, 2002

8:30 - 9:00	Welcome and Review of Findings from Day One
9:00 - 10:30	Discussion Session: Methodology and Interviews <i>Participants will be asked to review and comment on the methodology proposed for collecting the data for the 2003 report. Key questions may include:</i> <ul style="list-style-type: none"> <i>Given the time frame and resource constraints, are there additional analytical techniques you would suggest for collecting and analyzing the data?</i> <i>Are there other data sources not identified that you would recommend researching?</i> <i>Are there additional communities that you would recommend for case studies?</i>
10:30 - 10:45	Break
10:45 – 12:00	Discussion Session: Methodology and Interviews Continued
12:00 – 1:00	Working Lunch (served at Marasco Newton Group facility)
1:00 – 2:30	Discussion of Next Steps and Future Recommendations

Appendix C: Clarifying Questions from Observers

In order to maintain the focus on public health aspects and not broader EPA policy or program concerns, discussion at workshop sessions, comments, and input was restricted to the 13 invited experts. At the end of each day, the floor was opened to the observers for questions of clarification and additional topics. Comments from observers were collected on cards and incorporated into the discussion as appropriate. The comments, questions, and suggestions received during the meeting are listed below:

Suggestions

- Chicago might be a good case study community, as they seem proactive in monitoring the health of their wastewater treatment plant workers.
- Look to NIOSH with respect to biosolids.
- Do not forget to address algae, specifically its toxins, in the report.

Questions related to this Report to Congress

- Can you address how these pathogens can be transmitted from industries and commercial establishments as well as homes into sewer overflows?
- How will the Report to Congress relate the human health impacts of CSOs and SSOs to other sources of contamination (e.g., septic systems, storm water)? How will Congress know who is the biggest contributor of problems on a “big picture” basis?
- What impacts are most significant from a long-term health perspective?
- For EPA to assess the costs to control impacts, it is necessary to know what controls will control the most serious disease risks. What is the panel’s opinion of the most serious diseases? What controls will be most effective?
- Congress did not ask for health *risks*, it asked for health *impacts* and costs to address the impacts. Urban stream data show contamination in dry weather (e.g., Four Mile Run in Arlington, VA). Eliminating CSOs and SSOs will not make these streams safe. How will EPA explain SSO impacts and abatement costs when eliminating the overflows will not make the stream swimmable?
- How does EPA plan to characterize the health impacts (not health risks) to Congress? Illnesses per 100,000?

Policy and broader Report questions

- What is the appropriate frequency and duration for bacterial indicators?
- National policy (law) allows four CSO overflows per year (a controversial but common view). The SSO rule proposes zero SSOs. What is the panel’s opinion as to the qualitative benefit of the increased level of control called for in SSOs? Congress will ask this question if it is not in the report.
- Considering the generally high flow in wet weather conditions (3 inches of rain), is there a significant health risk associated with the four overflows per year standard for CSOs? Note that EPA’s Report to Congress estimates CSO abatement costs based on four CSOs per year. No estimates for controls that would achieve zero CSO events have been published.

**Appendix D: The Public Involvement Process for the 2001 and 2003 Reports
to Congress**

The Public Involvement Process for the 2001 and 2003 CSO/SSO Reports to Congress: A Community-Based Approach

This fact sheet explains the public involvement process for the 2003 Report to Congress (RtC) on CSOs and SSOs. Topics discussed include: the rationale behind EPA's public involvement process, the roles of various stakeholder groups in the process, and the environmental and social benefits achieved.

Why is EPA preparing this Report to Congress (RtC)?

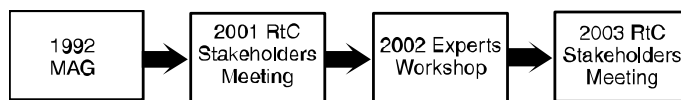
The Wet Weather Water Quality Act of 2000 requires that EPA transmit two Reports to Congress: the first, which was delivered earlier this year, examined the implementation and enforcement of the 1994 CSO Control Policy; the second is to investigate the environmental and human health impacts of CSOs and SSOs, the resources spent to control these impacts, and the technologies available for control.

Why has EPA established a Public Involvement Process as part of the development of the RtC?

Communities around the country struggle to manage their water resources to balance public health, environmental, and economic concerns. Many face aging water supply and sewage treatment infrastructure, increasing demand due to suburban residential and commercial development, and intense pressure to address environmental and public health issues. Nationwide data collection on sewer overflows is difficult because of the disincentives for reporting sewage infrastructure problems. In addition, it is often difficult to attribute the human health and environmental impacts associated with raw sewage to specific sources.

This public involvement process initially resulted from stakeholders' concerns about the future of CSO and SSO control. EPA has long recognized the need to listen to those who may be affected by its policies and has increasingly sought to involve stakeholders at earlier stages of research and policy formation. Accordingly,

EPA is drawing upon a broader community to refine research methods and verify information for the development of this report. This process represents EPA's sustained commitment to its diverse network of stakeholders.



What public involvement has occurred so far?

The Management Advisory Group (MAG)

EPA's CSO control program has a strong history of inclusivity and stakeholder involvement dating back to the development of the National CSO Control Strategy, released in 1989. To incorporate regulated community and environmental group concerns with the National CSO Control Strategy, EPA convened a Management Advisory Group (MAG). The MAG developed a CSO Framework Document that EPA used to develop the CSO Control Policy in 1994, hailed by many stakeholders as a landmark compromise between the various stakeholders. This early collaboration also laid a foundation for future cooperation between EPA, the regulated community, environmental groups, and other interested parties.

2001 Report to Congress Stakeholders Meeting

In July 2001, EPA's Office of Water convened stakeholders from the regulated community and

The Public Involvement Process (cont'd)

environmental groups in Chicago to discuss the findings of the 2001 Report to Congress on the Implementation and Enforcement of the Combined Sewer Overflow (CSO) Control Policy. Agency staff heard directly from the country's most experienced CSO stakeholders about the state of CSO Policy implementation. Topics discussed at the meeting included the report methodology, findings and recommendations, participants' experiences in CSO control, and future policy and program directions. This dialogue helped refine EPA's vision for the 2003 RtC and allowed for a meaningful exchange of ideas between EPA and various stakeholders.

2002 Experts Workshop

Because human health and environmental impacts associated with CSOs and SSOs are largely unknown, EPA is holding a Health Effects Experts Workshop in the summer of 2002. The purpose is to enlist technical and subject matter experts from federal agencies and academia to ensure that EPA asks the right study questions and develops a methodology that bears out actual experiences. To select the appropriate experts, EPA is soliciting input from traditional stakeholders through an Ad hoc Consultation Group made up of representatives from the CSO Partnership, the Association of Metropolitan Sewerage Agencies, the Water Environment Federation, and the Natural Resources Defense Council. The input of this Ad hoc Consultation Group will promote early collaboration and solidarity on the structure of, and the data sources used to support, the 2003 RtC.

The actual Workshop participants will lend their expertise, as it relates to CSOs and SSOs, in the area of human health effects. EPA expects to gain detailed insight into the measurement of human health impacts of CSO and SSO events and other information that might be inaccessible using available reporting mechanisms. Specifically, the Experts Workshop will verify, test, and

affirm methodologies to be used in the report (to eliminate gaps and redundancies), as well as identify and validate data sources. It enables the EPA Office of Water to establish connections within the academic and technical communities that the Office can draw upon in the future and promotes good relations with stakeholders and the public.

2003 Report to Congress Stakeholders Meeting

The 2003 Stakeholders Meeting will be similar to the 2001 Stakeholders Meeting. At the 2003 Stakeholders Meeting, parties from the public health, environmental, and regulated communities will have an opportunity to comment on the preliminary findings of the RtC and discuss its implications for policy and implementation. In addition, Stakeholders will have an opportunity to discuss the future direction of CSO and SSO programs, integration with other watershed or wet-weather issues, and overlaps with other agency programs. EPA will present of the results of the data collection, request verification of information and data sources, and solicit feedback on preliminary findings and interpretations. EPA anticipates that the 2003 Stakeholders Meeting will result in a refined analysis and interpretation of data. EPA also hopes to generate an atmosphere of goodwill and inclusivity and to gain insight into how best to communicate the release of the RtC.

In sum...

- CSO and SSO control has a history of increasing stakeholder involvement.
- EPA plans to expand its outreach efforts for the 2003 RtC to include public health representatives as well as traditional regulated community and environmental stakeholders.
- These efforts will continue to build bridges for future EPA efforts to protect the environment and human health.